



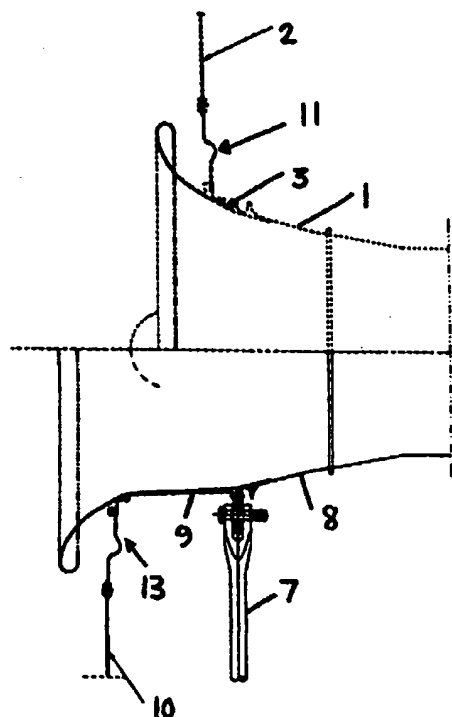
## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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| (51) International Patent Classification <sup>6</sup> :<br><b>F02C 7/20, F01D 25/28</b>  | <b>A1</b>  | (11) International Publication Number: <b>WO 97/30276</b><br>(43) International Publication Date: 21 August 1997 (21.08.97) |
| <p>(21) International Application Number: PCT/NO96/00278</p> <p>(22) International Filing Date: 22 November 1996 (22.11.96)</p> <p>(30) Priority Data:<br/>960571 13 February 1996 (13.02.96) NO</p> <p>(71) Applicant (for all designated States except US): KVÆRNER ENERGY A.S [NO/NO]; Kvæmerveien 10, N-0192 Oslo (NO).</p> <p>(72) Inventors; and<br/>(75) Inventors/Applicants (for US only): JAHR, Knut [NO/NO]; Harald Hårfagres vei 26c, N-1412 Sofiemyr (NO). FREY, Tom, Erik [NO/NO]; Kisaveien 67, N-2078 Nordkisa (NO).</p> <p>(74) Agent: TOFTING, Arild; Bryns Patentkontor a/s, P.O. Box 765, Sentrum, N-0106 Oslo (NO).</p> | <p>(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, US, UZ, VN, ARIPO patent (KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).</p> <p><b>Published</b><br/>With international search report.<br/>In English translation (filed in Norwegian).</p> |   |

(54) Title: TURBINE PACK AND METHOD FOR ADAPTING A TURBINE PACK

## (57) Abstract

A device and method for adapting a turbine package, comprising a turbine and a frame (R), where the turbine comprises an inlet bell mouth (1, 4, 8) and/or an exhaust bell mouth, and where there is a difference in length between two or more dissimilar models of turbines, so that the anchorage points (12, 13) of the bell mouth door (2, 5) or the plenum wall for the turbines do not correspond. The adaptation may, for example, be carried out either by extending the inlet bell mouth (8) of the shorter turbine, so that the anchorage points (12, 13) of the bell mouth doors (5, 10) of the two turbines correspond and by producing the frame so that the bell mouth door (10) is positioned in accordance with the corresponding anchorage points (12, 13), or by providing the bell mouth door with a conical section (24) having a length corresponding to the length difference between the turbines.



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# **TURBINE PACK      AND      METHOD FOR ADAPTING A TURBINE PACK**

The invention relates to a turbine package, and to a method  
5 for adapting a turbine package, according to the preamble to  
claims 1 and 8.

A widely used gas turbine, having the designation LM 2500,  
from General Electric, is produced in two models, the  
10 standard version LM 2500 PE (PE) and a new, upgraded model  
having the designation LM 2500 Plus (Plus).

The Plus version is upgraded from an output of 22 MW for the  
PE version to 29 MW. The main change made during the  
15 upgrading consists in introducing a zero step in the compres-  
sor, so that the flow volume through the turbine is increased  
by 23%. The new step increases the length of the turbine by  
13,38" (34 cm). This increase in length results in making  
the PE and the Plus turbine non-interchangeable, in particu-  
20 lar because the bell mouth door of the PE turbine package  
would collide with the support bracket anchorage points of  
the Plus turbine if a Plus turbine were placed in a PE  
turbine package. It is not possible to change the anchorage  
points of the turbine, since these are carefully determined  
25 with respect to the natural frequency of the turbine, thermal  
influences, the distribution of forces and the flow charac-  
teristics at the inlet.

Accordingly, in case of a future upgrading by means of a  
30 change from a PE turbine to a Plus turbine, this increased  
length will involve substantial reconstruction of the turbine  
package (which comprises turbine, frame and supporting means  
for the turbine). The reconstruction will be costly and  
will entail a lengthy standstill before the new turbine can  
35 be put into service. Moving the inlet bell mouth door is  
particularly problematic. The mountings for the turbine on  
the frame cannot be used either, and it is therefore, in

general, just as simple to exchange the whole frame, a process which obviously is very expensive. Moreover, this will make it impossible to change back to a PE turbine later, for example as a reserve turbine when the Plus turbine is  
5 undergoing repairs, etc.

The object of the present invention is to solve this problem in a manner which makes it possible to use the same frame for both the PE turbine and the Plus turbine. This is  
10 achieved by the features apparent from the characterizing clause of the subsequently disclosed claims 1 and 8.

In addition, possibilities have been explored for using at least some of the same anchorage points on the frame for  
15 support brackets and stays for the two turbine types. This is made possible in that the brackets and stays are interchangeable with brackets and stays adapted to each turbine type.

20 The invention will now be further explained with reference to the enclosed drawings wherein

Fig. 1 shows, on top, a section of one end of the PE turbine and, at the bottom, one end of a Plus turbine, both having  
25 regular standard inlet bell mouths;

Fig. 2 shows, on top, the same end of the PE turbine having a regular inlet bell mouth, like in Fig. 1, and, at the bottom, the same end of the PE turbine having a modified  
30 bell mouth:

Figs. 3 and 4 show a Plus turbine, seen from the side and from the end, respectively;

35 Figs. 5 and 6 show a modified PE turbine seen from the side and from the end, respectively;

Figs. 7 and 8 show another modified PE turbine seen from the side and from the end, respectively;

5 Figs. 9 and 10 show a PE turbine seen from the side and the end, respectively, the bell mouth door having been modified whereas the turbine itself is standard.

10 In the upper part of Figure 1, there is depicted one end of a PE turbine A having an inlet bell mouth 1. A bell mouth door 2, extending substantially perpendicularly out from the inlet bell mouth 1, is connected to the bell mouth 1 at an anchorage point 11. One may also glimpse an anchorage point 3 for securing a support running from the bell mouth to the turbine frame R (see Figure 5).

15 In the lower part of Figure 1, one end of a Plus turbine B having an inlet bell mouth 4 is depicted. Here, as well, a bell mouth door 5 is connected to the bell mouth 4 at an anchorage point 12, and there is an anchorage point 6 for connection with a support 7 for the turbine connected to the bell mouth. Here it is seen that the increased length  $L_t$  of the Plus turbine B entails that the position of the bell mouth door 5 having the anchorage point 12 for the Plus turbine B is extensively displaced in relation to the position of the bell mouth door 2, having anchorage point 11 for the PE turbine A, and that the bell mouth door 2 would come into conflict with the anchorage point 6 for the support 7. Mounting the Plus turbine B on the frame R of the PE turbine A is thus impossible without extensive modification of the frame R since the placement of said anchorage point for the bell mouth door will not correspond with the new turbine.

30 In figure 2, the upper part is identical to the upper part of Figure 1 and shows one end of the PE turbine A, including an inlet bell mouth 1, a bell mouth door 2 having an anchorage point 11, and an anchorage point 3. The lower part shows,

however, a modified bell mouth for a PE turbine A, where the bell mouth 1 is extended with a distance piece 9 so that the bell mouth door 10 having an anchorage point 13 will be located at the same place as the bell mouth door 5 for the Plus turbine B. Thus, the new Plus turbine B may be mounted directly on the same frame as the PE turbine A without the bell mouth door and its position needing to be modified, this frame R having already been prepared to receive a Plus turbine B.

10

In Figure 3 the Plus turbine B is shown in its entirety, viewed from the side. A support bracket 14 with pertaining stay 7 is also shown here. In Figure 4 two support brackets 14 and 15 are shown with pertaining stays 7 and 16. The support brackets are secured to the frame R in anchorage points 17 and 18. The frame and the turbine are enclosed in a housing, a wall of which is formed by the bell mouth door 2.

20 In Figures 5 and 6 the modified PE turbine A from Figure 2 is shown schematically in its entirety, viewed, respectively, from the side and from the end. Thus, it is here seen that the extension of the bell mouth 1 by means of the distance piece 9 entails that turbine A becomes as long as turbine B in Figure 3. A support bracket 19 and two stays 20 and 21, devised to secure turbine A to the frame R, are also shown. Here it is seen that the support bracket 19 is secured in the same anchorage point 17 on the frame R as the bracket 14 in Figs. 3 and 4, whereas the stay 21 is fastened to an anchorage point 22.

35 In Figures 7 and 8 a somewhat different version of a modified PE turbine A is shown. Instead of adding the distance piece 9, the bell mouth 1 is here exchanged with a completely novel and longer bell mouth 23. The bell mouth 23 exceeds the standard bell mouth length of the PE turbine A by a length Lt.

In Figures 9 and 10 there is shown another way of adapting a turbine package so that it may comprise PE turbine A and Plus turbine B, respectively. Instead of extending the bell mouth 1 of the PE turbine A, an adaptation has here been carried out of the bell mouth door 2 so that it has been provided with a conical section 24, extending from the plane of the bell mouth door to a plane that cuts through the anchorage points 11 for the bell mouth door on the bell mouth 1. When the Plus turbine B is to be mounted on the frame R the conical section 24 is removed and replaced by a standard bell mouth door.

Although the preceding description is based on specific turbine types, it is obvious that the art described above may also be used for any other combination of turbine types. Nor is there any limitation with respect to the invention in the number of steps the upgrading may contain. It will therefore be theoretically possible to use the described art also for upgrading procedures comprising 4 or 5 steps for exchanging the turbine with turbines of a longer type. Downgrading to turbines of a shorter type is also theoretically possible by means of the described art.

Moreover, the invention is not limited to use in connection with longitudinal adaptation at the inlet end, but can also be used in an analogous manner by adaptation of the outlet end. For turbines using an inlet plenum and an outlet plenum instead of a housing having a bell mouth door, the longitudinal adaptation may be achieved in a manner exactly analogous to that described in the preceding pages. The plenum wall will then replace the bell mouth door.

Patent Claims

1.

A turbine package,

5 c h a r a c t e r i z e d i n t h a t i t c o m p r i s e s

- a turbine A of a first type  $T_a$  having a total length  $L_a$ ,  
said turbine A comprising an inlet bell mouth (1) and/or  
an exhaust bell mouth, provided with an anchorage point  
10 for a bell mouth door or a plenum wall, or
- a turbine B of a second type  $T_b$  having a total length  $L_b$ ,  
said turbine comprising an inlet bell mouth (4) and/or an  
exhaust bell mouth, provided with an anchorage point for a  
15 bell mouth door or a plenum wall, and
- a frame (R), said frame (R) being provided with a bell  
mouth door (2) or a plenum wall, provided with an  
anchorage point for a turbine inlet bell mouth and/or an  
20 exhaust bell mouth, said frame (R) comprising anchorage  
points for support brackets and/or stays for mounting a  
turbine on the frame (R),
- where the two turbine types  $T_a$  and  $T_b$  are different and  
25 the length  $L_a$  is shorter than the length  $L_b$ , and
- where the inlet area and/or the exhaust area of the  
turbine package is extended by a length  $L_t$  corresponding  
to the difference between the length  $L_a$  and the length  $L_b$ ,  
30
- so as to make possible thereby the mounting of either  
turbine A or turbine B on the frame (R) without requiring  
a change lengthwise in the position of the bell mouth door  
(2) or the plenum wall on the frame (R).

35

2.

A device according to claim 1,



c h a r a c t e r i z e d i n that the inlet bell mouth (1) and/or the exhaust bell mouth has been extended by a length  $L_t$  corresponding to the difference between the length  $L_a$  and the length  $L_b$ , so that the anchorage point on turbine A for the bell mouth door (2) or plenum wall of the frame (R) corresponds, in the longitudinal direction of the turbine, to the anchorage point on turbine B for the bell mouth door (2) or plenum wall of the frame (R).

3.

A device according to claim 1, c h a r a c t e r i z e d i n that the bell mouth door (2) or plenum wall of the frame (R) has been provided, for the mounting of turbine A, with a substantially conical portion extending from the plane of the bell mouth door (2) or the plenum wall to the anchorage point for the bell mouth door or plenum wall on the inlet bell mouth (1) or exhaust bell mouth, said conical portion having a length  $L_t$ , and that the bell mouth door (2) or the plenum wall, for the mounting of turbine B, is generally plane, so that the mounting connectors of the bell mouth door or the plenum wall on the inlet bell mouth at all times correspond to the anchorage points on the inlet bell mouth or the exhaust bell mouth for the bell mouth door or plenum wall.

25

4.

A device according to claim 2, c h a r a c t e r i z e d i n that the bell mouth (1) is extended by the introduction of a distance piece (9) having a length  $L_t$ .

30

5.

A device according to claim 2, c h a r a c t e r i z e d i n that the bell mouth (1) is exchanged with a new bell mouth which is longer than the bell mouth (1) by a distance  $L_t$ .

35

6.

A device according to claims 1, 2, 3, 4 or 5,  
c h a r a c t e r i z e d i n that it as an alternative to  
turbine A or B may comprise a turbine C, optionally a  
5 plurality of turbines, having a length  $L_c$  which lies between  
 $L_a$  and  $L_b$  or is shorter than  $L_a$  or longer than  $L_b$ , the inlet  
area and/or exhaust area being extended a length  $L_f$  corre-  
sponding to the difference in length between any of the  
lengths  $L_a$ ,  $L_b$  and  $L_c$ .

7.

A device according to any one of the preceding claims,  
c h a r a c t e r i z e d i n that the support brackets  
and/or stays for mounting the turbine on the frame (R) are  
15 exchangeable and that the support brackets and/or stays  
adapted to mount turbine A may be secured to at least some of  
the anchorage points on the frame (R) for support brackets  
and/or stays adapted to mounting turbine B, and, optionally,  
that support brackets adapted to mount turbine C may be  
20 secured to at least some of the anchorage points on the frame  
(R) for support brackets and/or stays adapted for mounting  
turbine A and/or turbine B.

8.

25 A method for adapting a turbine package,  
c h a r a c t e r i z e d b y extending the inlet area of  
the turbine package, said turbine package comprising

- a turbine A of a first type  $T_a$  having a total length  $L_a$ ,  
30 said turbine A comprising an inlet bell mouth (1) and/or  
an exhaust bell mouth, provided with an anchorage point  
for a bell mouth door or a plenum wall, or
- a turbine B of a second type  $T_b$  having a total length  $L_b$ ,  
35 said turbine comprising an inlet bell mouth (4) and/or an  
exhaust bell mouth, provided with an anchorage point for a  
bell mouth door or a plenum wall, and

- a frame (R), said frame (R) being provided with a bell mouth door (2) or a plenum wall, provided with an anchorage point for a turbine inlet bell mouth and/or an exhaust bell mouth, said frame (R) comprising anchorage points for support brackets and/or stays for mounting a turbine on the frame (R),
- where the two turbine types Ta and Tb are different and the length La is shorter than the length Lb, and
- where the inlet area and/or the exhaust area of the turbine package is extended by a length Lt corresponding to the difference between the length La and the length Lb,
- so as to make possible thereby the mounting of either turbine A or turbine B on the frame (R) without requiring a change lengthwise in the position of the bell mouth door (2) or the plenum wall on the frame (R).

9.

A method according to claim 8,

characterized in that the inlet bell mouth (1) and/or the exhaust bell mouth is extended by a length Lt corresponding to the difference between the length La and the length Lb, so that the anchorage point on turbine A for the bell mouth door (2) or plenum wall of the frame (R) corresponds, in the longitudinal direction of the turbine, to the anchorage point on turbine B for the bell mouth door (2) or plenum wall of the frame (R).

10.

A method according to claim 8,

characterized in that the bell mouth door (2) or plenum wall of the frame (R) is provided, for the mounting of turbine A, with a substantially conical portion extending from the plane of the bell mouth door (2) or the plenum wall

to the anchorage point for the bell mouth door or plenum wall on the inlet bell mouth (1) or exhaust bell mouth, said conical portion having a length  $L_t$ , and that the bell mouth door (2) or the plenum wall, for the mounting of turbine B, is generally devised as a plane part, so that the mounting connectors of the bell mouth door or the plenum wall on the inlet bell mouth at all times correspond to the anchorage points on the inlet bell mouth or the exhaust bell mouth for the bell mouth door or plenum wall.

10

11.

A method according to claim 9, characterized in that the bell mouth (1) is extended by the introduction of a distance piece (9) having a length  $L_t$ .

15

12.

A method according to claim 9, characterized in that the bell mouth (1) is exchanged with a new bell mouth which is longer than the bell mouth (1) by a distance  $L_t$ .

20

13.

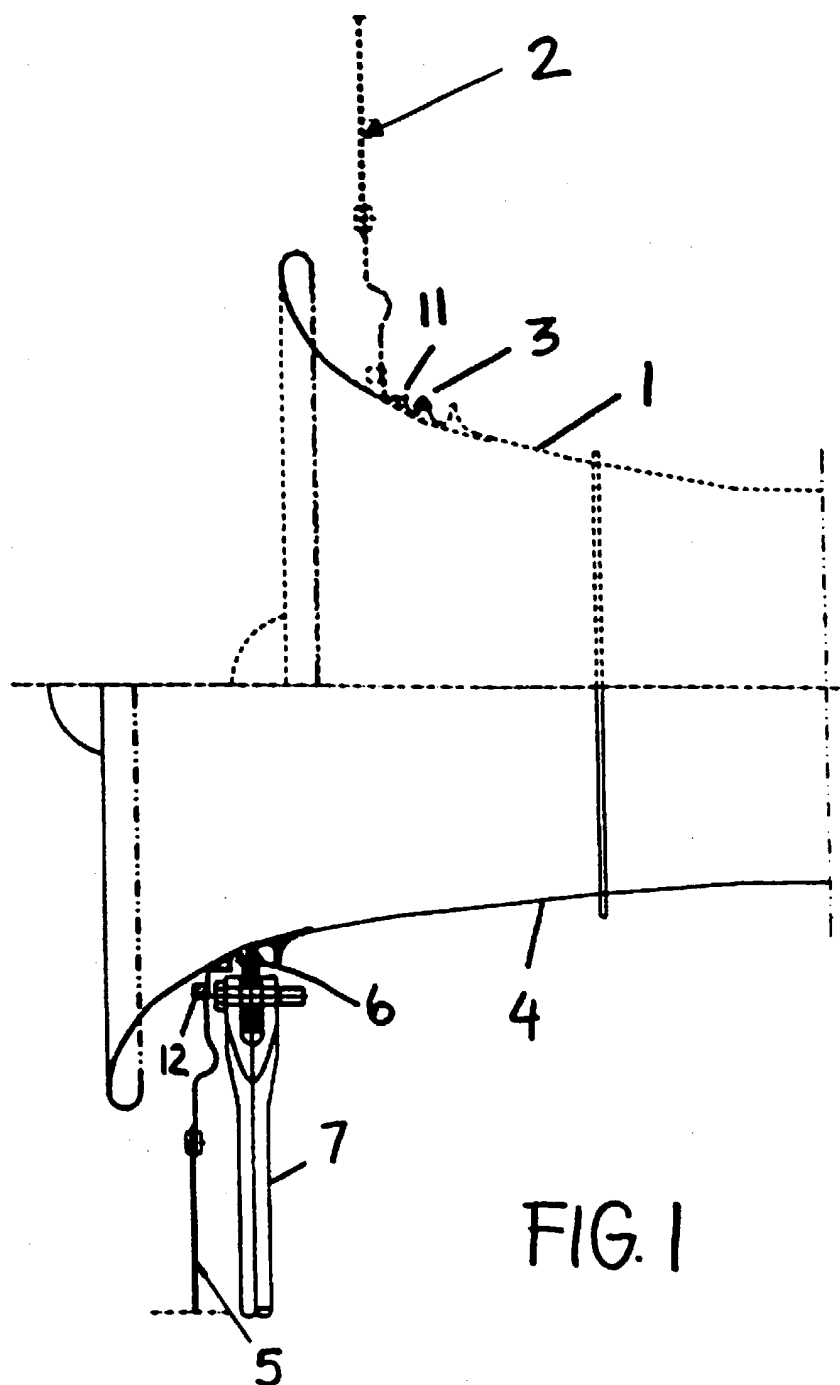
A method according to claims 8, 9, 10, 11 or 12, characterized in that the turbine package as an alternative to turbine A or B may be provided with a turbine C, optionally a plurality of turbines, having a length  $L_c$  which lies between  $L_a$  and  $L_b$  or is shorter than  $L_a$  or longer than  $L_b$ , the inlet area and/or exhaust area being extended a length  $L_f$  corresponding to the difference in length between any of the lengths  $L_a$ ,  $L_b$  and  $L_c$ .

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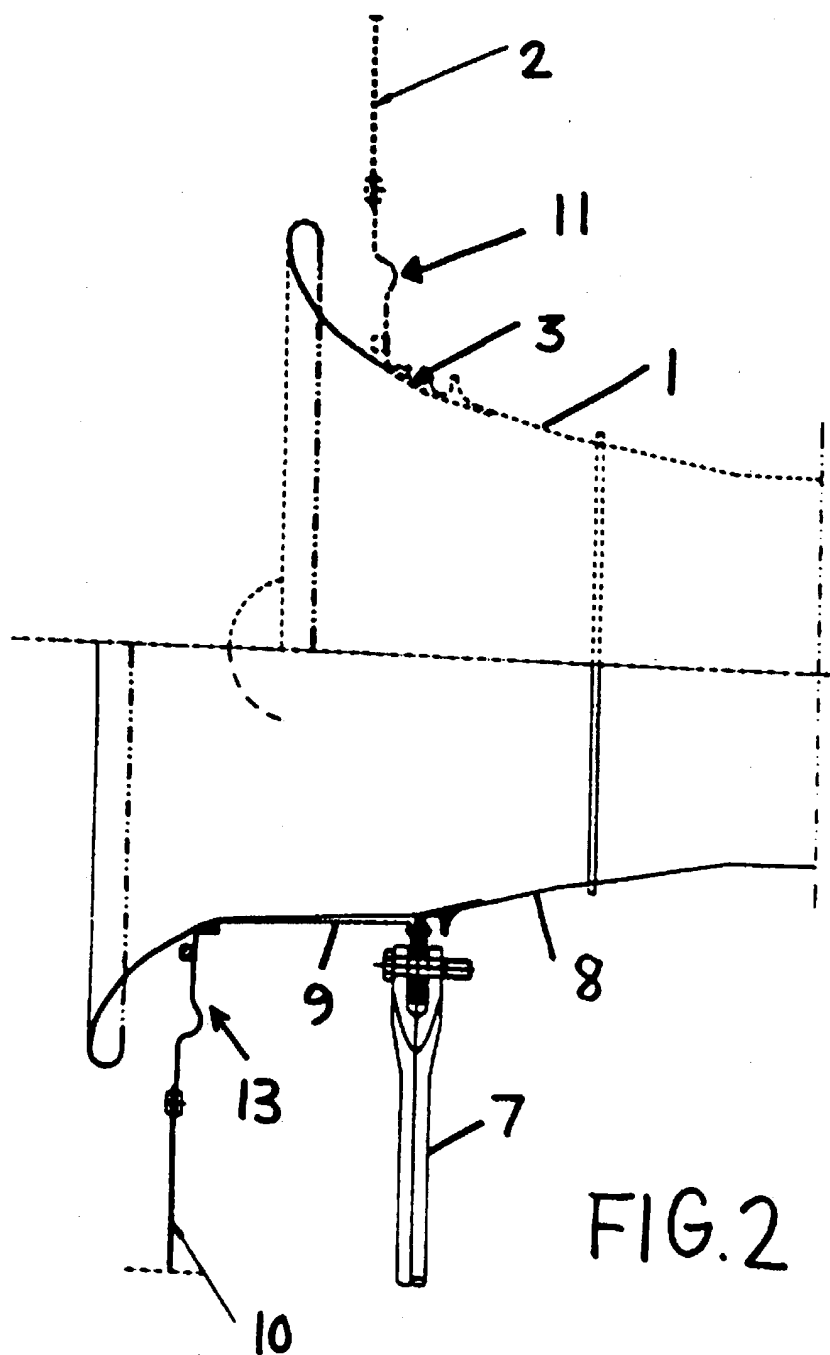


FIG. 2

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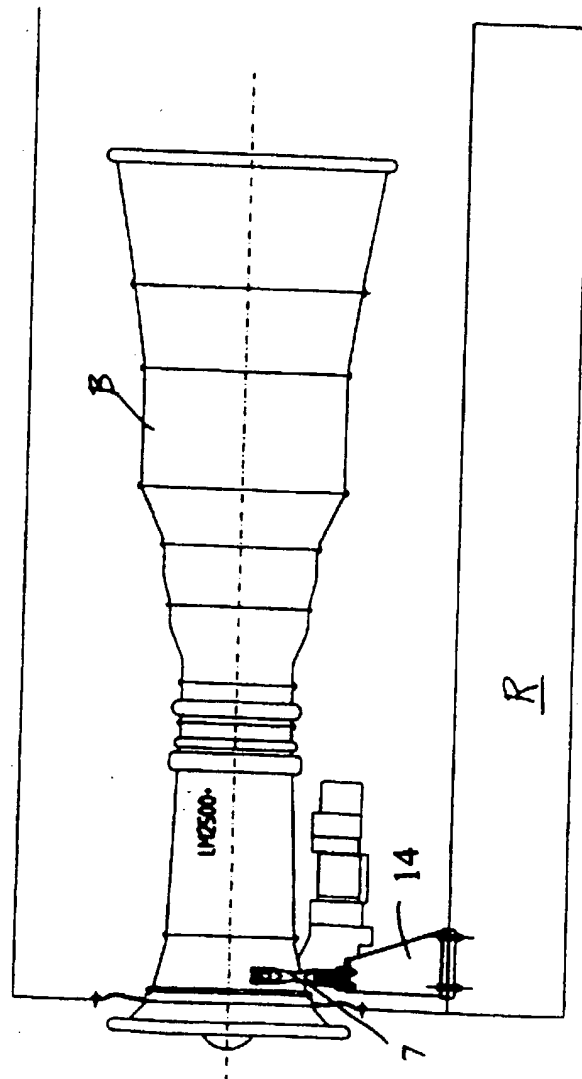


Fig. 3

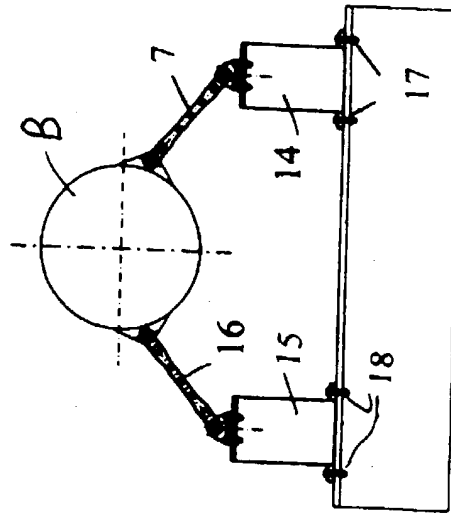


Fig. 4

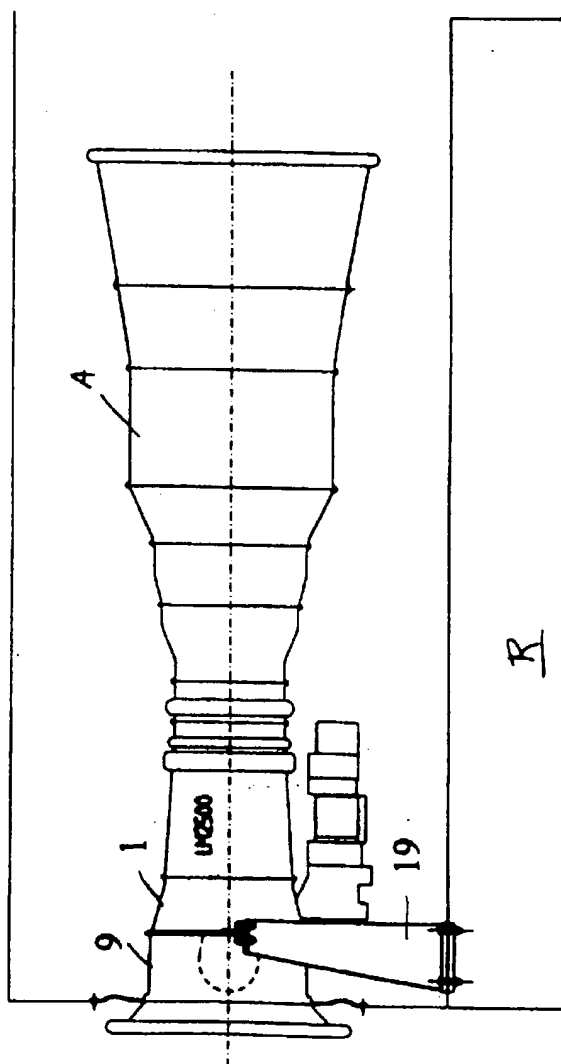


Fig. 5

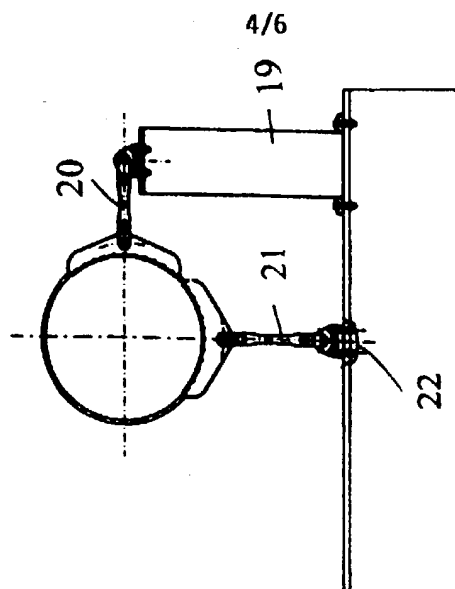


Fig. 6



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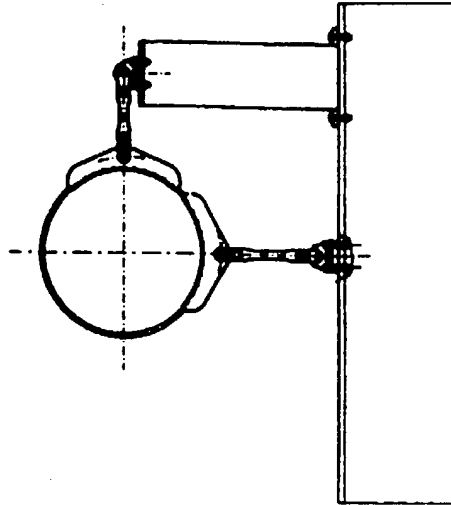


Fig. 8

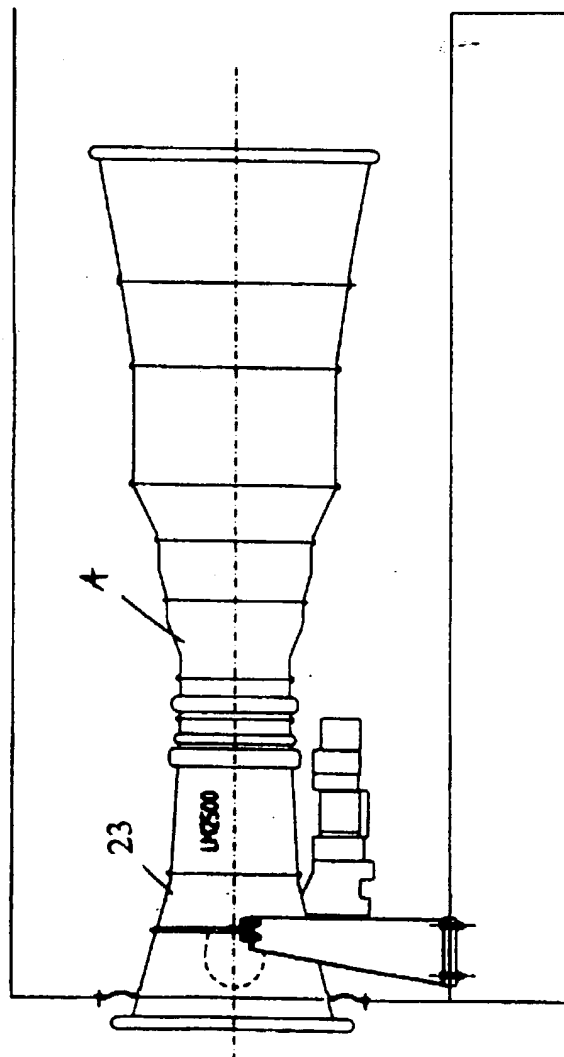


Fig. 7

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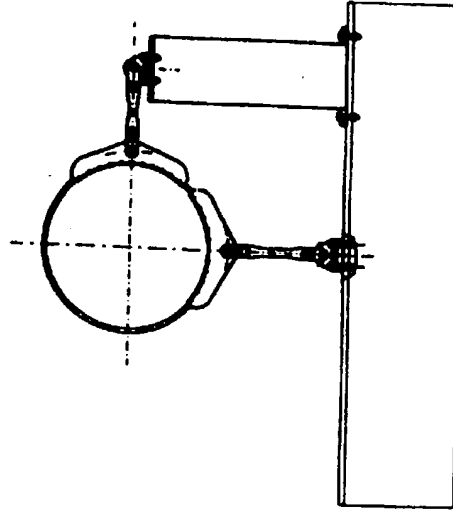


Fig. 10

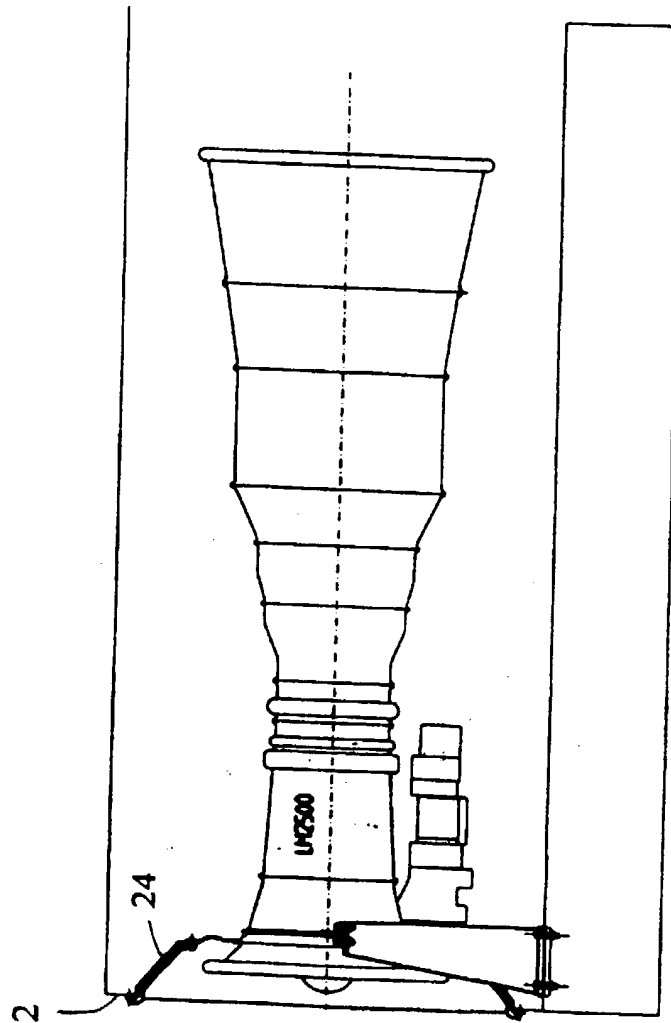


Fig. 9

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/NO 96/00278

| <b>A. CLASSIFICATION OF SUBJECT MATTER</b>  |  |  |
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| IPC6: F02C 7/20, F01D 25/28<br>According to International Patent Classification (IPC) or to both national classification and IPC  |  |  |
| <b>B. FIELDS SEARCHED</b>   |  |  |
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| <b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>   |  |  |
| Category*   | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No.  |
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| <input type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.  |  |  |
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| Date of the actual completion of the international search   |  | Date of mailing of the international search report                         |
| 23 April 1997   |  | 26 -04- 1997   |
| Name and mailing address of the ISA/<br>Swedish Patent Office<br>Box 5055, S-102 42 STOCKHOLM<br>Facsimile No. +46 8 666 02 86  |  | Authorized officer<br><br>Per-Olof Warnbo<br>Telephone No. +46 8 782 25 00 |

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## INTERNATIONAL SEARCH REPORT

Information on patent family members

02/04/97

International application No.

PCT/NO 96/00278

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